Lysack, W. 1980

1979 Cedar Lake Fish Stock Assessment Program

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1979 Cedar Lake Fish Stock Assessment Program.

Manitoba Department of Natural Resources, MS Report No. 80-17, 45pp.

ABSTRACT

A yearly fish stock assessment program was initiated on Cedar Lake in 1979 in response to continuing demands for increases in commercial quotas of Cedar Lake whitefish and walleyes.

Results of the 1979 sampling indicate that whitefish growth is positively allometric while walleye growth is negatively allometric. Walleye and whitefish growth equations are: Length = 33.679 + 12.947 Age and Length = 266.869 + 25.109 Age, respectively. Walford plots crossed the agreement line at 502 mm. for whitefish but did not cross the agreement line for walleyes.

Estimates of instantaneous total mortality rates of walleyes and whitefish from fall experimental and fall commercial data agreed closely and were 1.03, 1.15 and 0.97 and 1.03, respectively. Walleye mortality estimated from spring commercial samples was significantly lower than the fall estimate.

The maturity rate of walleyes was 11.89% $year^{-1}$. The instantaneous maturity rate of whitefish was 38.78% $log\ (year)^{-1}$. Abrasov's (1967) mean age of maturity was 5.08 years for walleyes and 3.96 years for whitefish. Ages at which 50% of the individuals are mature were 4.71 years for walleyes and 2.18 years for whitefish. Abrasov's (1967) t values for walleyes and whitefish were +1.21 years and +1.67 years, respectively. Commercial catches contained 14% immature walleyes and 10% immature whitefish.

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INTRODUCTION

A year-to-year fish stock assessment program on the Cedar Lake populations of walleye and whitefish was initiated in 1979 in response to continuing requests for quota increases from Cedar Lake commercial fishermen.

Variations in abundance of walleyes in the Cedar-Moose Lake complex were studied by Derksen (1967). Previous to this work, very few studies of Cedar Lake fish had been carried out. A tagging program on commercially important species in Cedar Lake was conducted by the Fisheries Branch, Man. Dept. of Mines, and Natural Resources (Sunde in Derksen 1967).

Sopuck (1979) investigated the Moose Lake walleye and whitefish commercial fisheries. Howard (1967a) and Doan (1979) described commercial catches of the Cedar Lake fishery before and after the hydroelectric impoundment at Grand Rapids. Howard (1967b) speculated on the viability of a "rough" fish fishery on Cedar Lake. Moshenko and McGregor (1978) supervised an experimental commercial fishery on Cedar Lake. They monitored mercury content, commercial catches, selective fishing and set experimental gangs.

Webb (1965) studies various limnological aspects of the southern basin of Cedar Lake in 1962. Derksen (1978) reported the mercury content of Cedar and Moose Lake fish species.

The general objective of this study was to begin monitoring and assessment of the Cedar Lake walleye and whitefish stocks. Specific objectives were:

1. to determine age compositions
2. to estimate mortality and survival rates

3. to describe maturity regimes

4. to describe growth regimes

5. to compare fish ages determined by examination of scales and of otoliths.

6. to determine the age compositions, mean lengths and weights, mean ages and mortality rates of commercially caught fish.

7. to relate the present status of fish stocks to that described by earlier workers and to discuss management implications.

Due to manpower restraints, experimental sampling was restricted to one period during early autumn. Commercial catches were sampled once in spring and once in fall. Only three experimental gangs were set.

METHODS AND MATERIALS

Experimental Netting

Three gangs of gillnets were set in Cedar Lake during early autumn (Fig. 1). Each gang was set for approximately 24 hours. Each gang was composed of the following meshes: 7.62 cm., 8.26 cm., 9.53 cm., 10.80 cm., 12.70 cm., and 13.34 cm. Each net in the gang was 45.72 m long and approximately 1.83 m deep.

Walleyes and whitefish caught in the gangs were processed as follows: The fork length of each fish was measured to the nearest 2 mm. Each fish was weighed to the nearest 20 gm on a Chatillon spring scale (Chatillon, Mississauga, Ontario). Six to ten scales were collected from the left side of each fish. Scales were removed above the lateral line below the anterior edge of the dorsal fin. Otoliths were collected from 86 walleyes which were caught by commercial fishermen. The sex and state of maturity of each fish was visually determined by examining gonads.

Fig. 1. Map of Cedar Lake. Sampling sites are indicated by stars.

Fish were classified as being either immature or mature. The mesh size that caught each fish was recorded.

Commercial Sampling

Samples of commercially caught walleyes and whitefish were collected in early June and in early September of 1979. 170 whitefish and 91 walleyes were sampled in June. 165 whitefish and 90 walleyes were sampled in September.

The fork length and round weight of each fish was recorded. Scales were collected from each fish as described in the experimental netting section.

The sex and state of maturity of each fish in the fall commercial sample was determined by visual examination of gonads.

Analyses

Scales and otoliths were analyzed according to Eriekson (1979). Routine statistical analyses were performed according to Snedecor and Cochran (1967). Total mortality rates were calculated according to Robson and Chapman (1961).

The mean weighted age of onset of sexual maturity was calculated as follows:

$$Z = \frac{A_1K_1 + A_2(K_2 - K_1) + A_3(K_3 - K_2) + \ldots + A_n(K_n - K_{n-1})}{K_1 + (K_2 - K_1) + (K_3 - K_2) + \ldots + (K_n - K_{n-1})}$$

where A = age (years)

K_n = % mature fish in the n^{th} age class

This is a corrected version of Abrasov's (1967) original formula. Mean age of the commercial catch and t were calculated according

to Abrasov (1967).

RESULTS

Experimental Netting

Age-specific mean lengths and weights of walleyes and whitefish (Table 1) were used to determine length-weight relationships (Table 2, Figs. 2, 3). Whitefish growth is positively allometric while walleye growth is negatively allometric.

Log transformations of length and of age did not improve correlations of length and age a great deal (Table 3). Thus untransformed data pairs were used in fitting growth curves (Table 4, Figs. 4, 5).

A Walford plot of walleye age-specific mean lengths (Fig. 6) did not cross the agreement line and L_∞ could not be calculated for walleyes (Table 5). A Walford plot of whitefish age-specific mean lengths (Fig. 7) yielded an L_∞ value of 502 mm (Table 5).

Three to twelve year old walleyes were caught in experimental nets. 5 and 6 year old walleyes dominated the walleye age composition which is leptokurtic and positively skewed (Fig. 8).

Three to nine year old whitefish were caught in experimental nets. 5 and 6 year old whitefish dominated the experimental catch. The whitefish age composition is also leptokurtic and is slightly positively skewed (Fig. 9).

Regression estimates of walleye and whitefish survival rates were significantly different from Robson-Chapman survival estimates (Table 6).

Table 1. Age-specific mean lengths and weights of Cedar Lake walleyes and whitefish, 1979.

Species	Age (years)	No. fish	Mean length (mm)	Mean weight (gm)
Walleye	3	15	388.40	813.33
	4	73	380.82	723.29
	5	168	393.83	817.14
	6	188	395.26	832.13
	7	117	409.76	903.76
	8	32	430.75	1035.63
	9	12	454.83	1340.00
	10	8	473.00	1347.50
	11	1	558.00	2320.00
	12	2	491.00	1500.00
Whitefish	3	8	320.75	557.50
	4	15	360.27	840.00
	5	41	417.51	1336.10
	6	46	434.78	1526.52
	7	25	453.36	1720.80
	8	6	458.00	1796.67
	9	3	478.00	2213.33

Table 2. Length-weight relationships of Cedar Lake walleyes and whitefish, 1979.

Species	Linear equation	Correlation coefficient	t F ratio and d.f.
Walleye	log(weight) = -10.831 + 2.934 log(length)	0.995	837.65(1,9)
Whitefish	log(weight) = -12.881 + 3.329 log(length)	0.999	1780.89(1,6)

Table 3. Correlation coefficients of growth equations fitted by least squares regression using various transformations.

Species	Transformation		
	untransformed	log(length) vs age	length vs log(age)
Walleye	0.942	0.947	0.874
Whitefish	0.951	0.936	0.984

Table 4. Growth curves of Cedar Lake walleyes and whitefish.

Species	Linear equation*	Test F ratio and d.f.
Walleye	Length = 331.679 + 12.947 age	47.23(1, 7)
Whitefish	Length = 266.869 + 25.109 age	47.26(1, 5)

*Data pairs involving less than 5 fish per age were deleted.

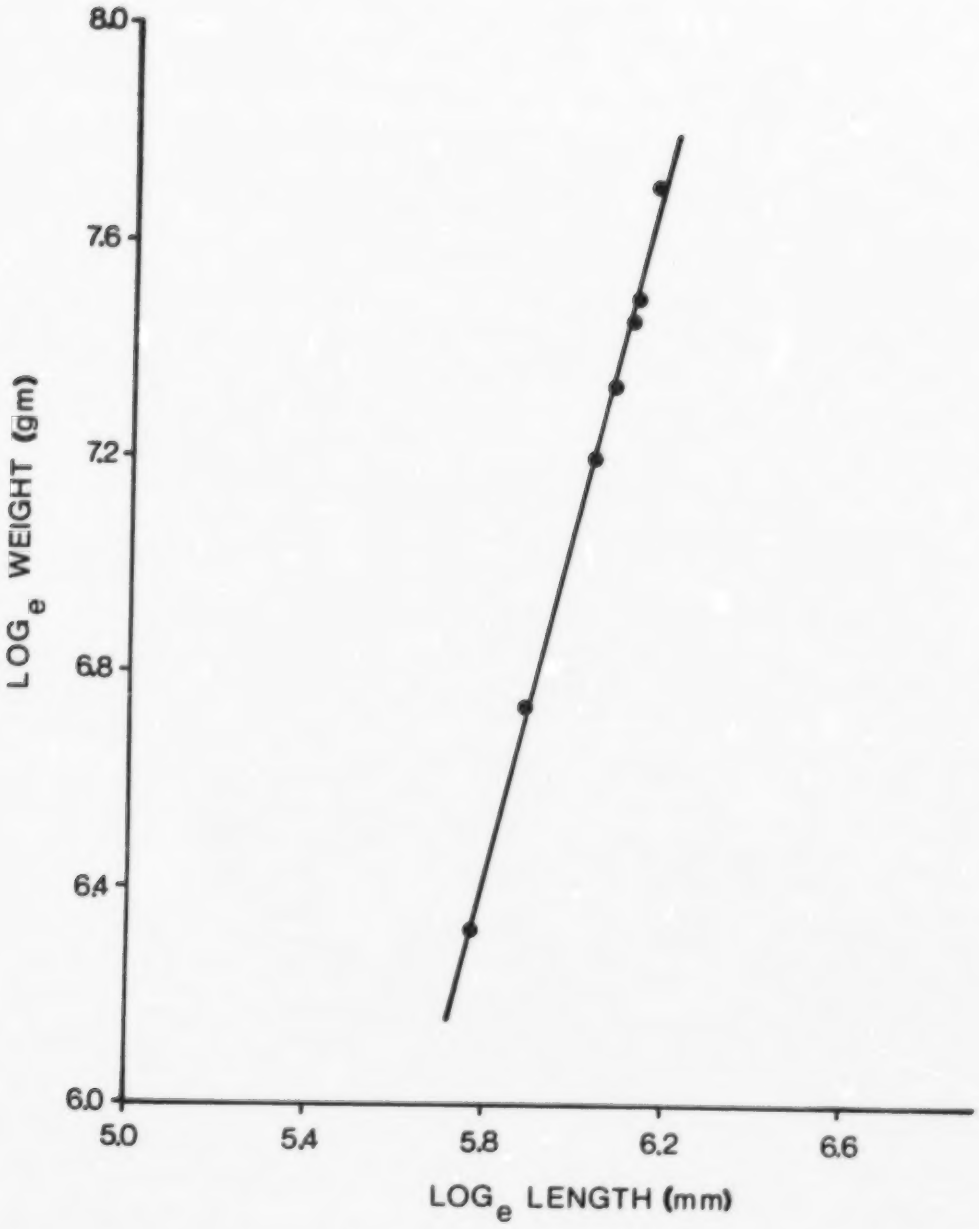

Fig. 2. Cedar Lake walleye length-weight relationship, 1979.

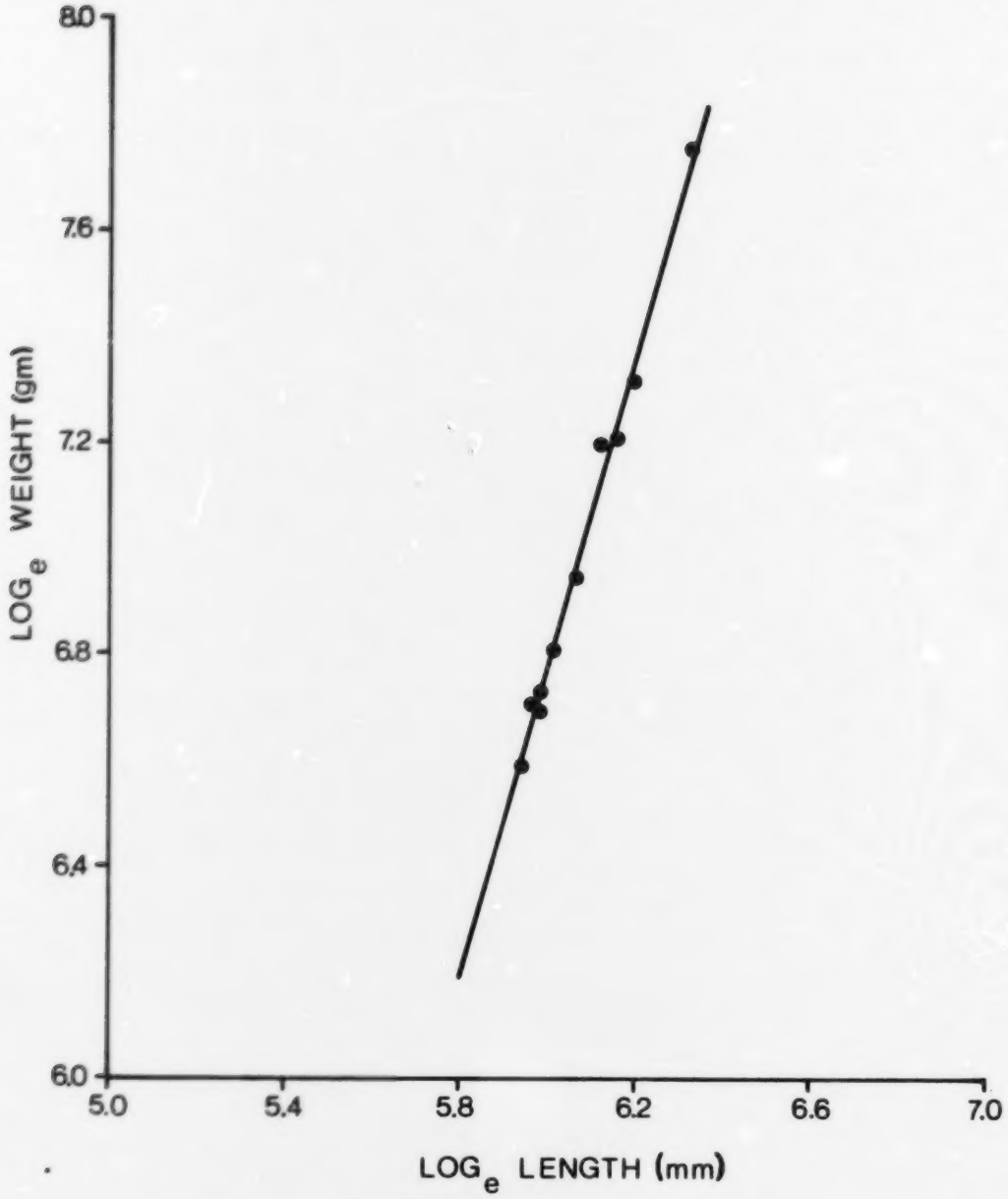

Fig. 3. Cedar Lake whitefish length-weight relationship, 1979.

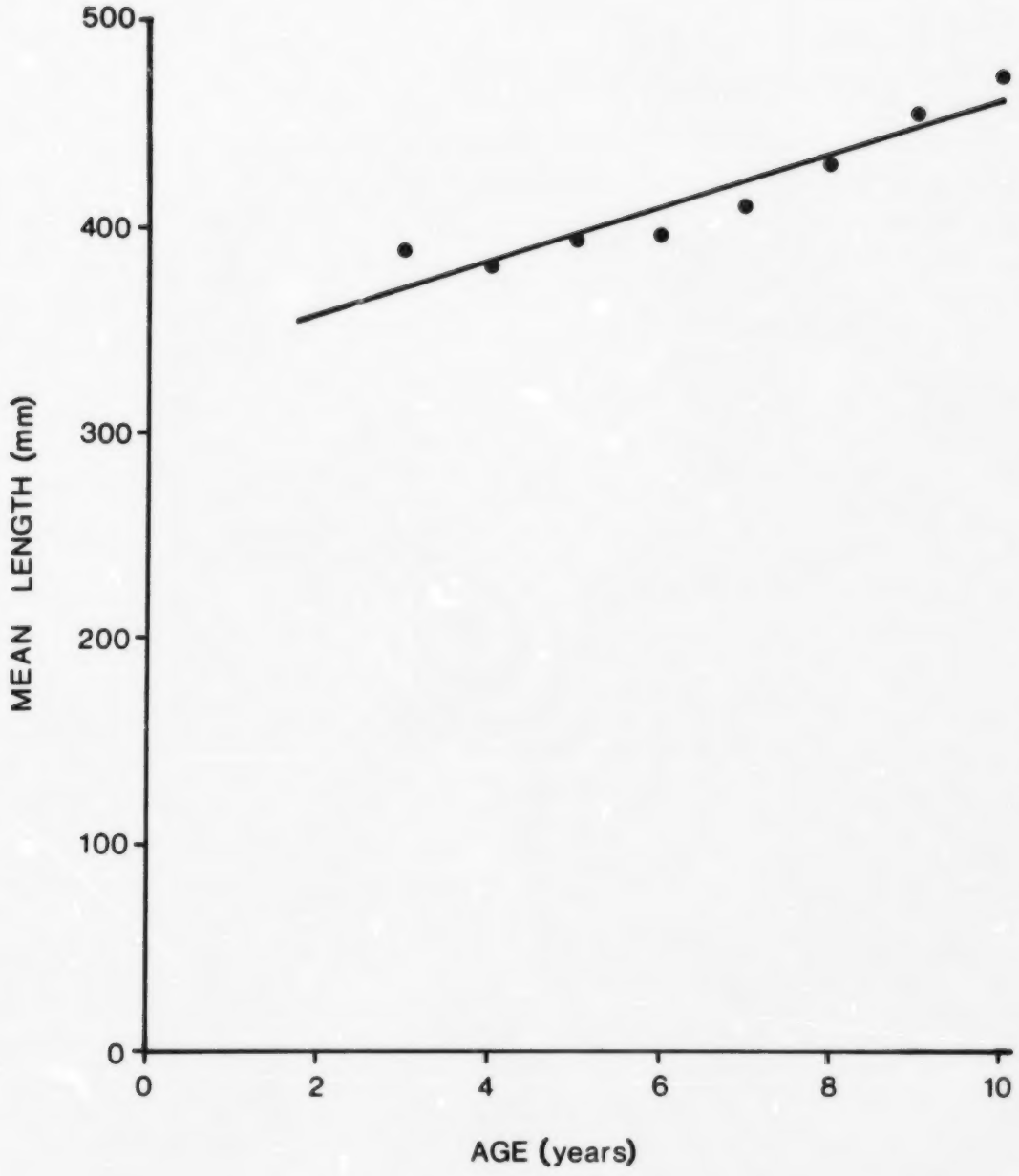

Fig. 4. 1979 Cedar Lake walleye growth curve fitted by least squares regression.

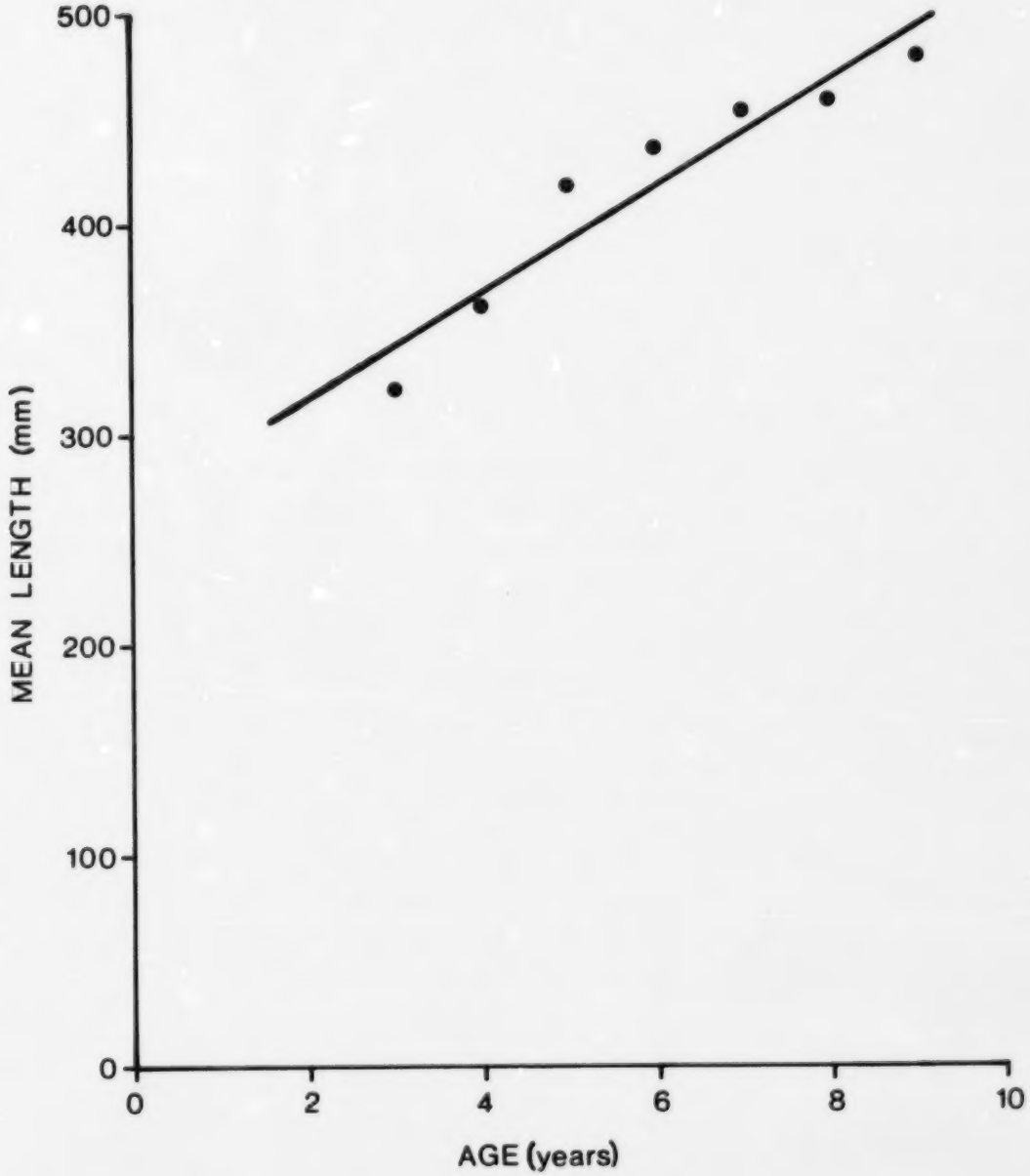

Fig. 5. 1979 Cedar Lake whitefish growth curve fitted by least squares regression.

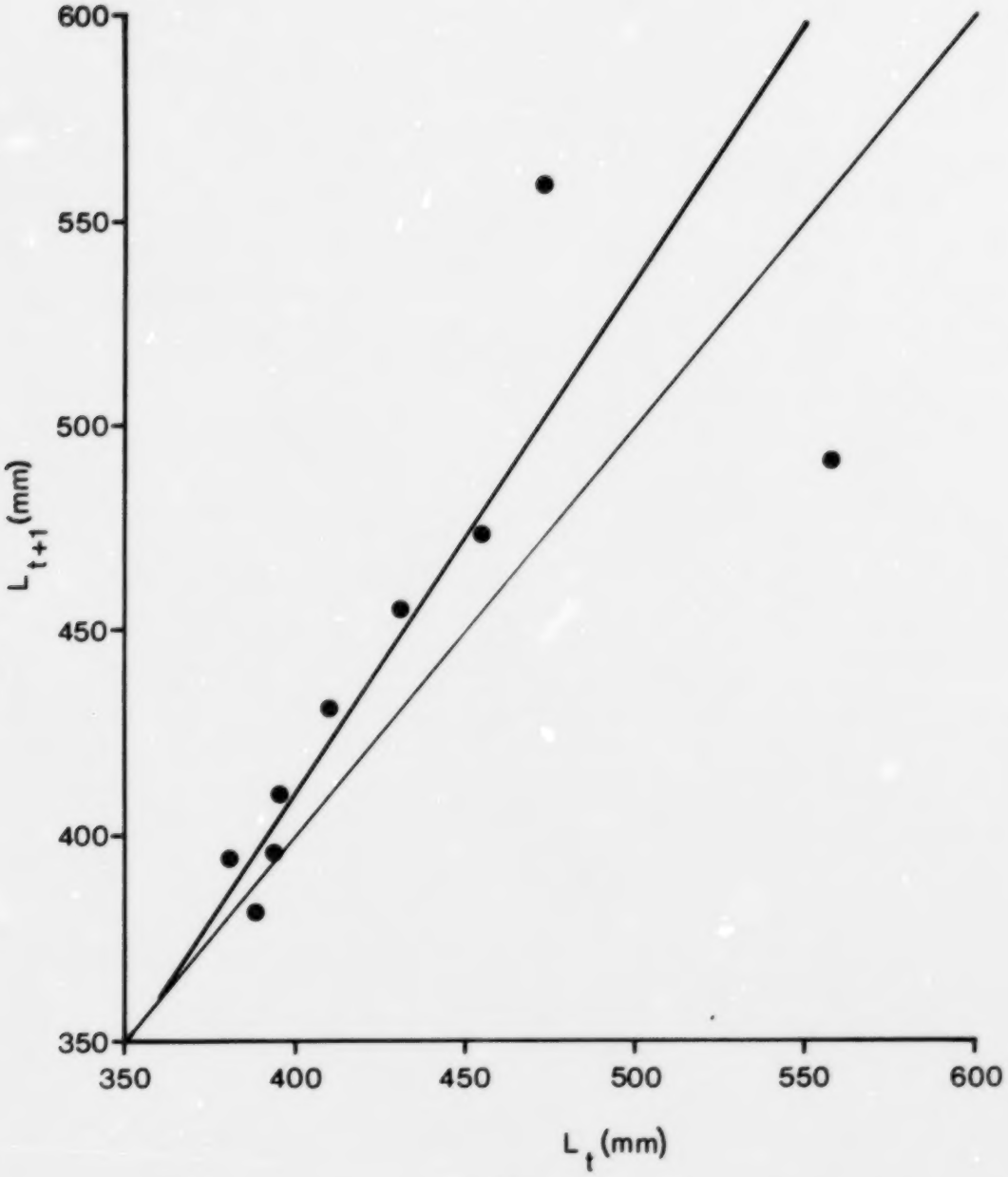

Fig. 6. Walford plot of walleye lengths. The last two points were deleted from regression analysis.

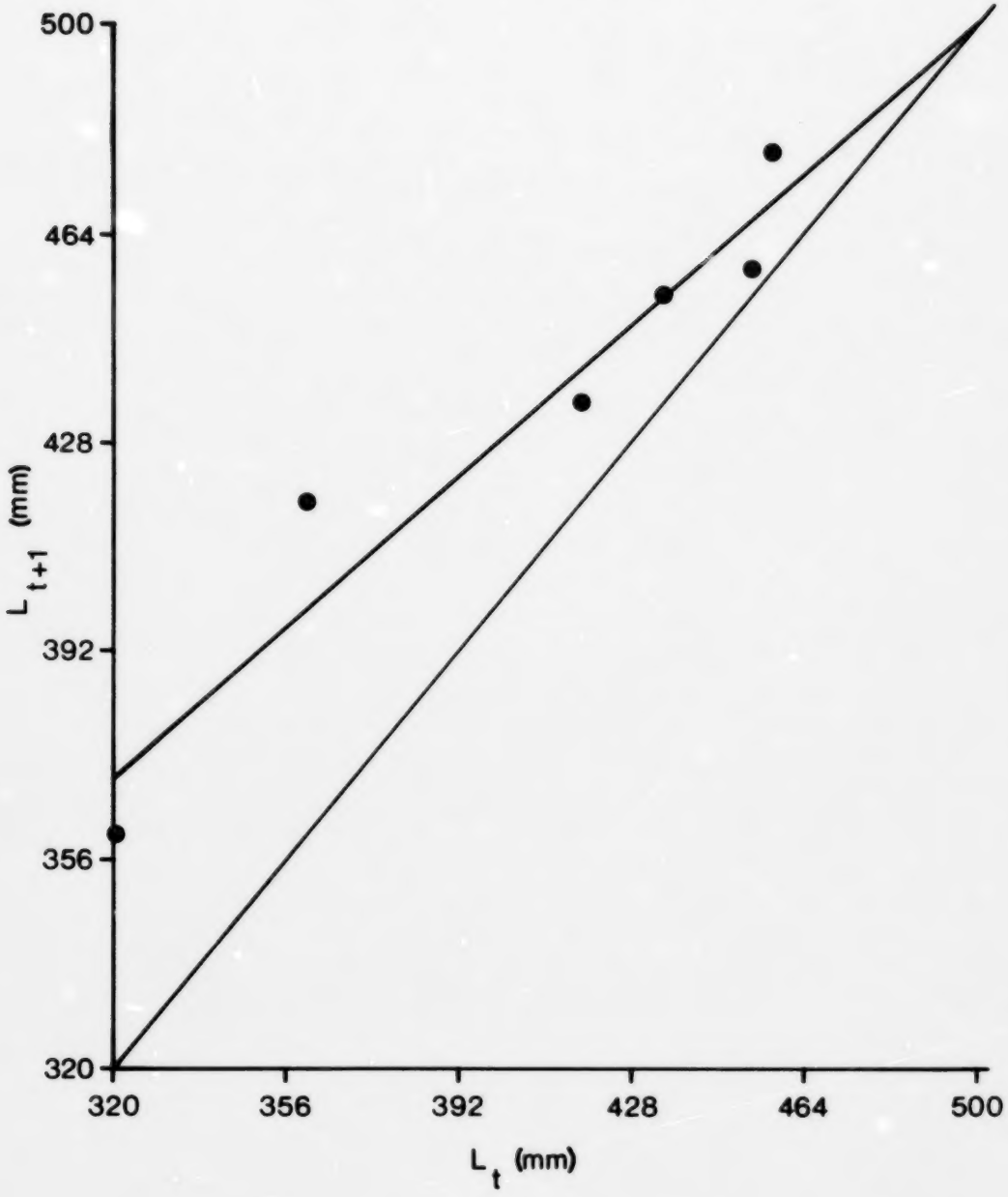

Fig. 7. Walford plot of whitefish lengths.

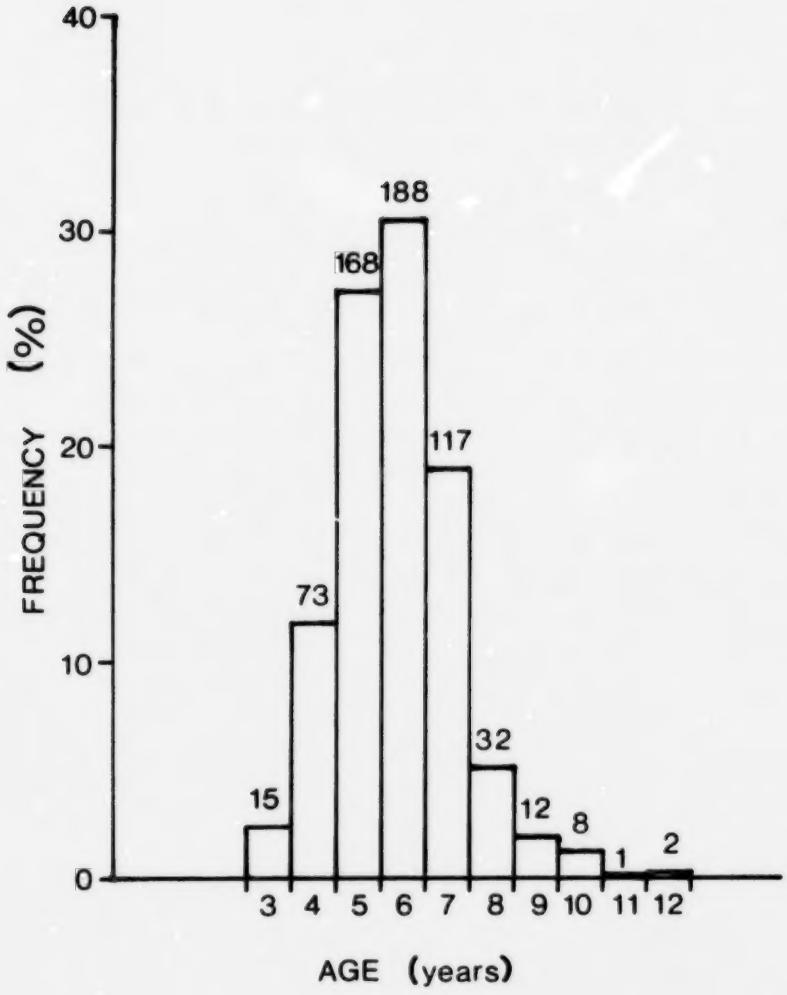

Fig. 8. Age composition of experimentally netted walleyes, from Cedar Lake, fall 1979. Numbers of fish in each age class are above each bar.

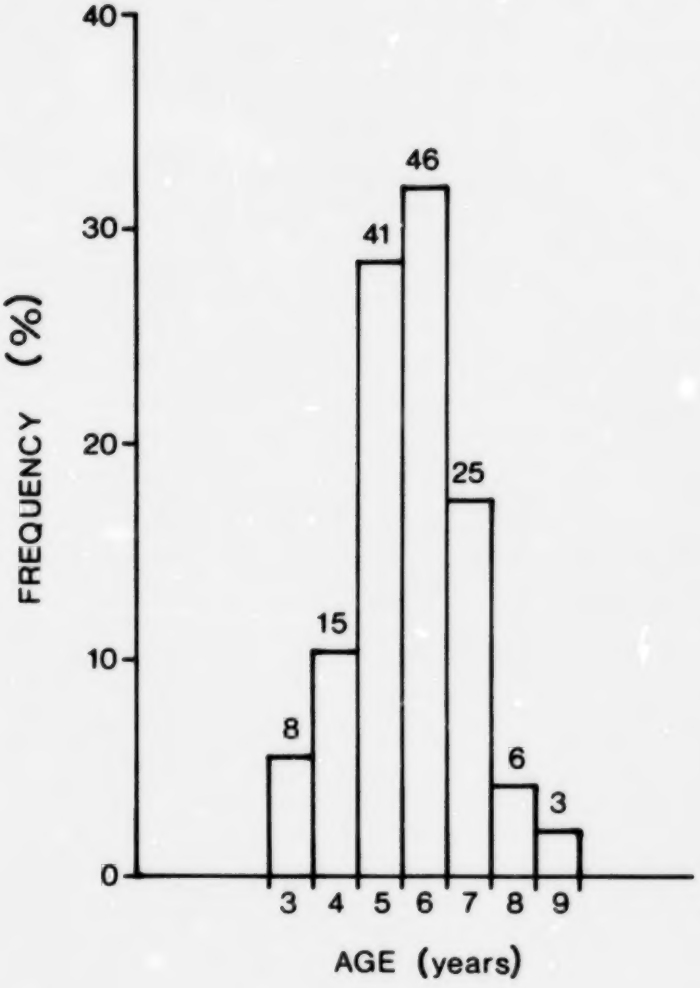

Fig. 9. Age composition of experimentally netted whitefish from Cedar Lake, fall 1979. Numbers of fish in each age class are above each bar.

Table 5. Walford curves of Cedar Lake walleyes and whitefish, 1979.

Species	Linear equation	L_∞ (mm)	Correlation coefficient	Test F ratio and d.f.
Walleye *	$L_{t+1} = 90.247 + 1.251\ L_t$	-	0.964	65.38(1, 6)
Whitefish	$L_{t+1} = 138.944 + 0.723\ L_t$	502	0.964	51.98(1, 5)

*last two data pairs deleted from analysis.

Table 6. Mortality and survival rates of Cedar Lake walleyes and whitefish estimated by regression and the Robson-Chapman method.

Sample type	Species	Robson-Chapman			Regression		
		Z	A	S ± 2 S.E.	Z	A	S
Fall experimental	walleye	1.03	0.6430	0.3558 ± 0.0744	0.808	0.5551	.4449
	whitefish	0.97	0.6209	0.3772 ± 0.0554	0.816	0.5596	.4404
Spring commercial	walleye	0.57	0.4345	0.5604 ± 0.0446	0.332	0.2811	.7189
	whitefish	1.28	0.7720	0.2787 ± 0.0739	1.001	0.6321	.3679
Fall commercial	walleye	1.15	0.6834	0.3169 ± 0.0680	0.875	0.5853	.4148
	whitefish	1.03	0.6430	0.3547 ± 0.0590	0.857	0.5768	.4232

Walleye and whitefish survival rates from the fall experimental and fall commercial samples were very similar. The walleye survival rate from the spring commercial sample was radically different from other walleye survival estimates (Table 6, Figs. 10, 11).

Abrasov's (1967) weighted mean ages of the onset of sexual maturity of walleyes and whitefish were 5.08 years and 3.96 years, respectively (Table 7). When the maturity schedules of walleye (Fig. 12) and whitefish (Fig. 13) were transformed by two methods, it was found that untransformed data yielded the highest correlation coefficient for walleyes and that logtransformed ages yielded the highest correlation for whitefish (Table 8). Curves that were fitted accordingly (Figs. 14, 15) had slopes that were statistically different from 0. The ages at which 50% of the fish are mature (interpolated from the fitted maturity curves) are 4.71 years for walleyes and 2.18 years for whitefish (Table 9). At any common age, mature male and female walleyes seem to have attained a larger body size than immature male and female walleye (Figs. 16, 17). The same trend exists for whitefish (Figs. 18, 19).

Age specific mean lengths and weights of commercially caught walleyes (Table 10) were greater than the mean lengths and weights of experimentally netted walleyes (Table 1). In general, mean lengths and weights of commercially caught whitefish (Table 10) were more similar to mean lengths and weights of experimentally netted whitefish (Table 1). Weighted mean ages of commercially caught walleyes and whitefish were 6.29 years and 5.63 years, respectively (Table 10). Abrasov's (1967) t index was +1.21 years for walleyes and +1.67 years for whitefish, using the corrected formula to estimate mean age of maturity. Using the inter-

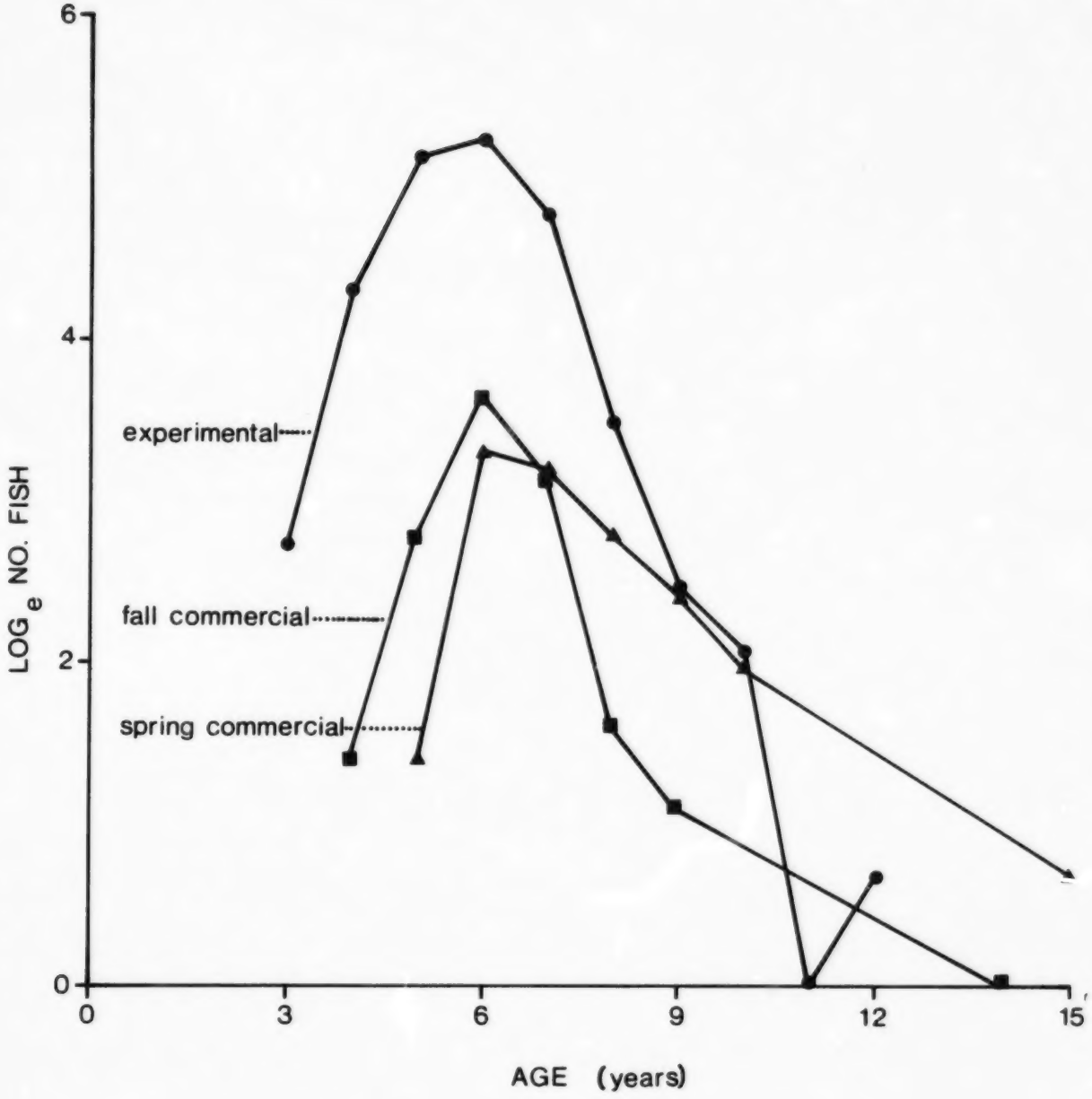

Fig. 10. Cedar Lake walleye catch curves from spring and fall commercial samples and from experimental netting.

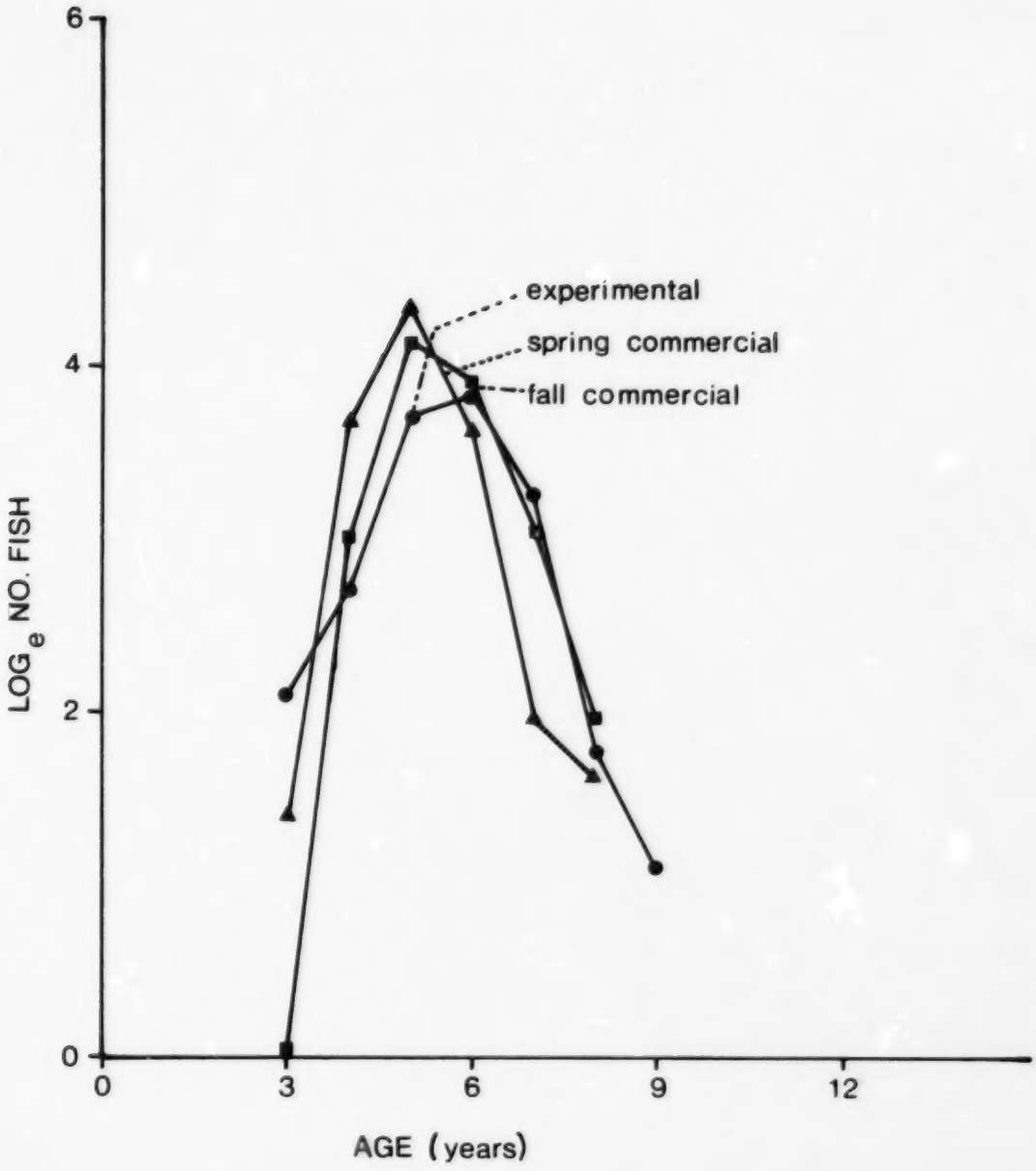

Fig. 11. Cedar Lake whitefish catch curves from spring and fall commercial samples and from experimental netting.

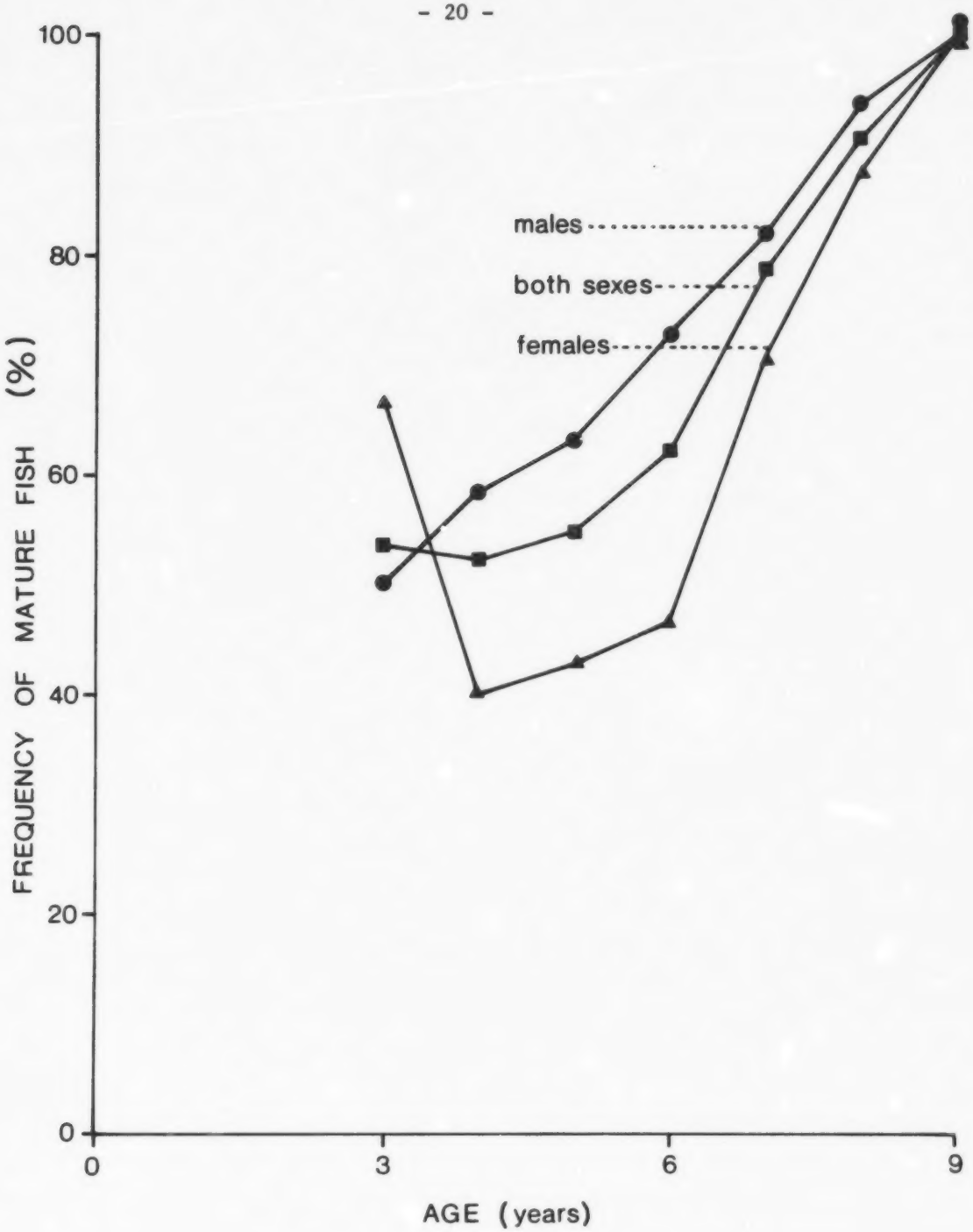

Fig. 12. Maturity schedule of Cedar Lake walleyes, 1979.

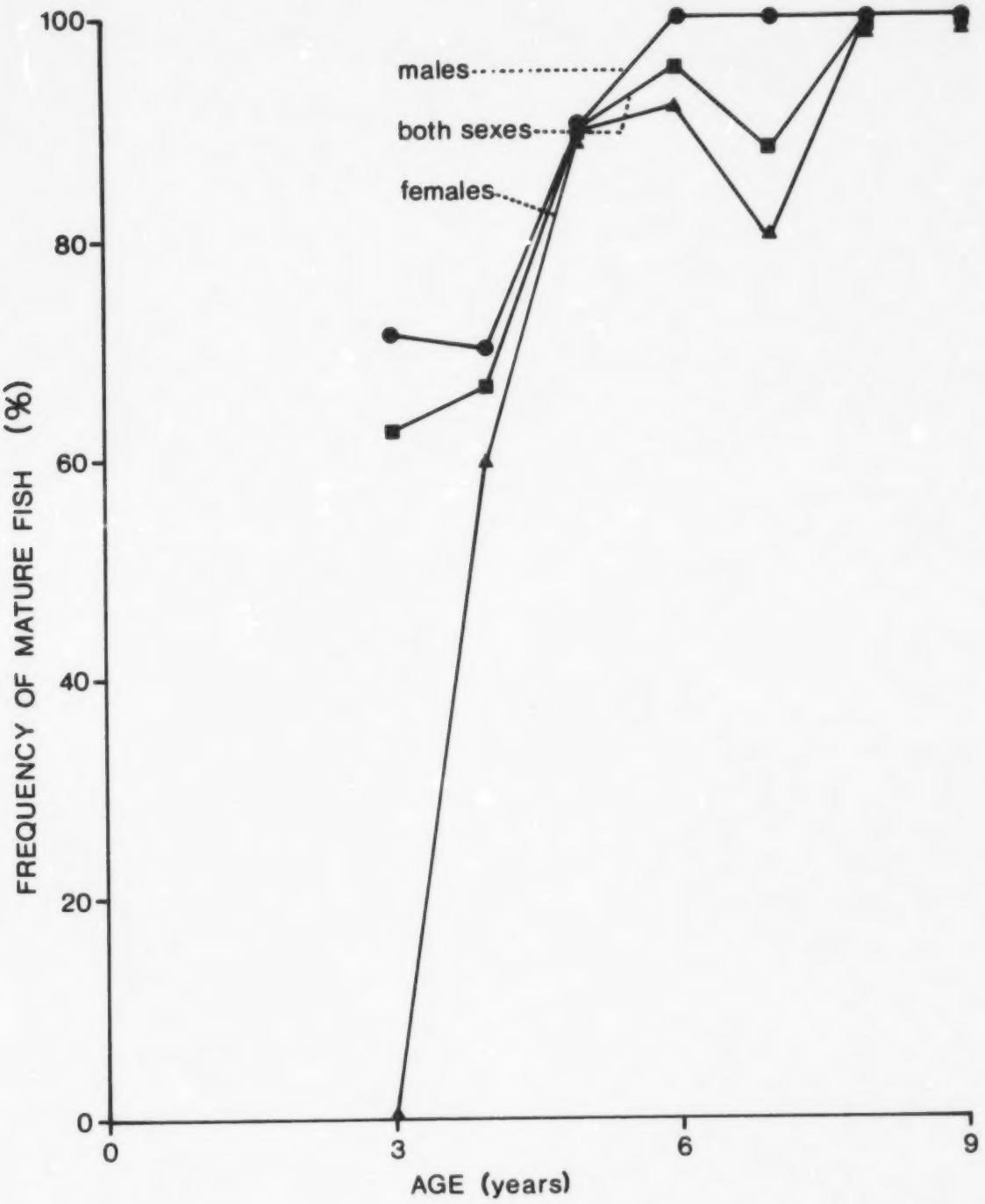

Fig. 13. Maturity schedule of Cedar Lake whitefish, 1979.

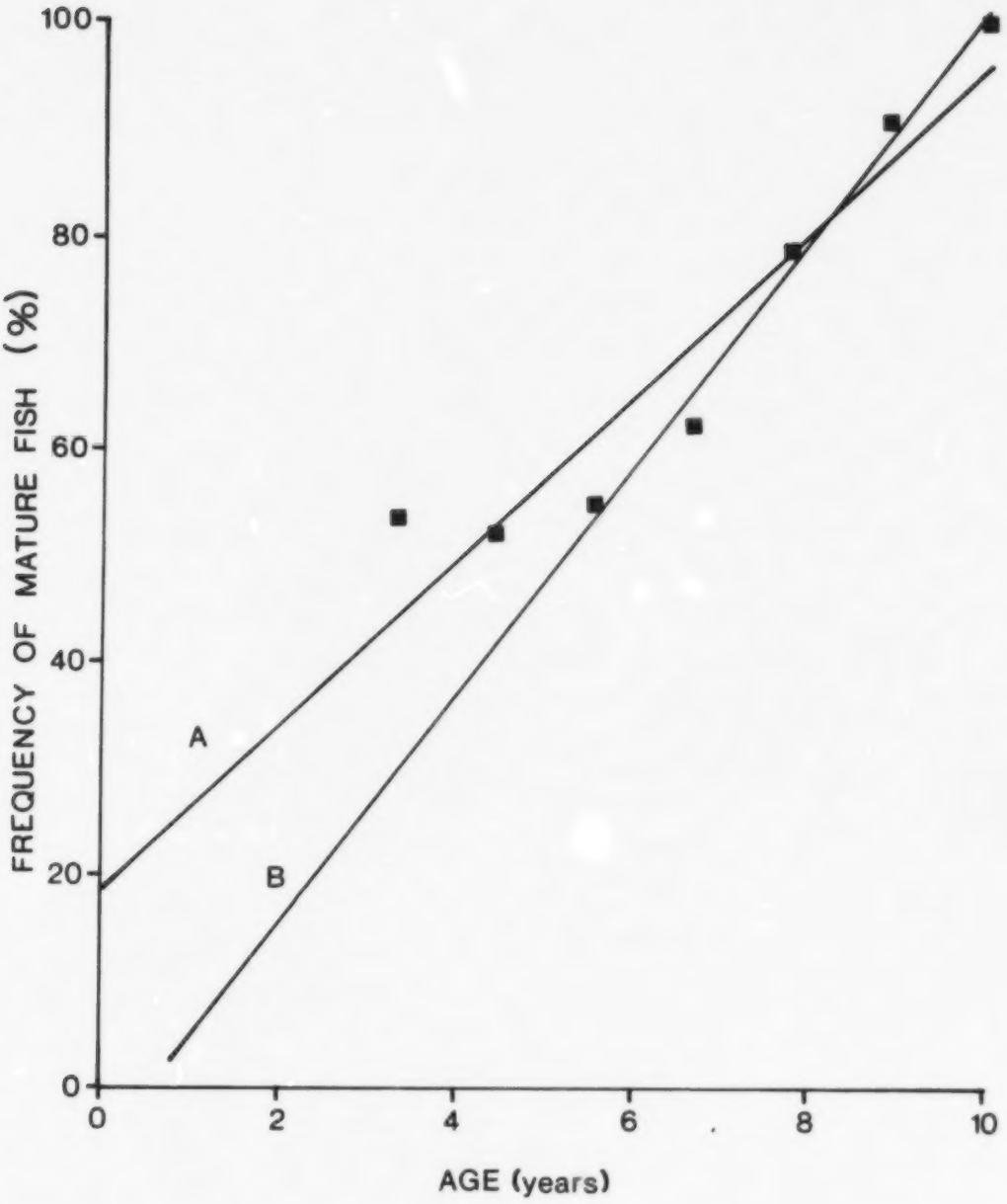

Fig. 14. Least squares regression lines fitted to the maturity schedule of Cedar Lake walleyes.
Curve a. using all data
Curve b. first two points deleted.

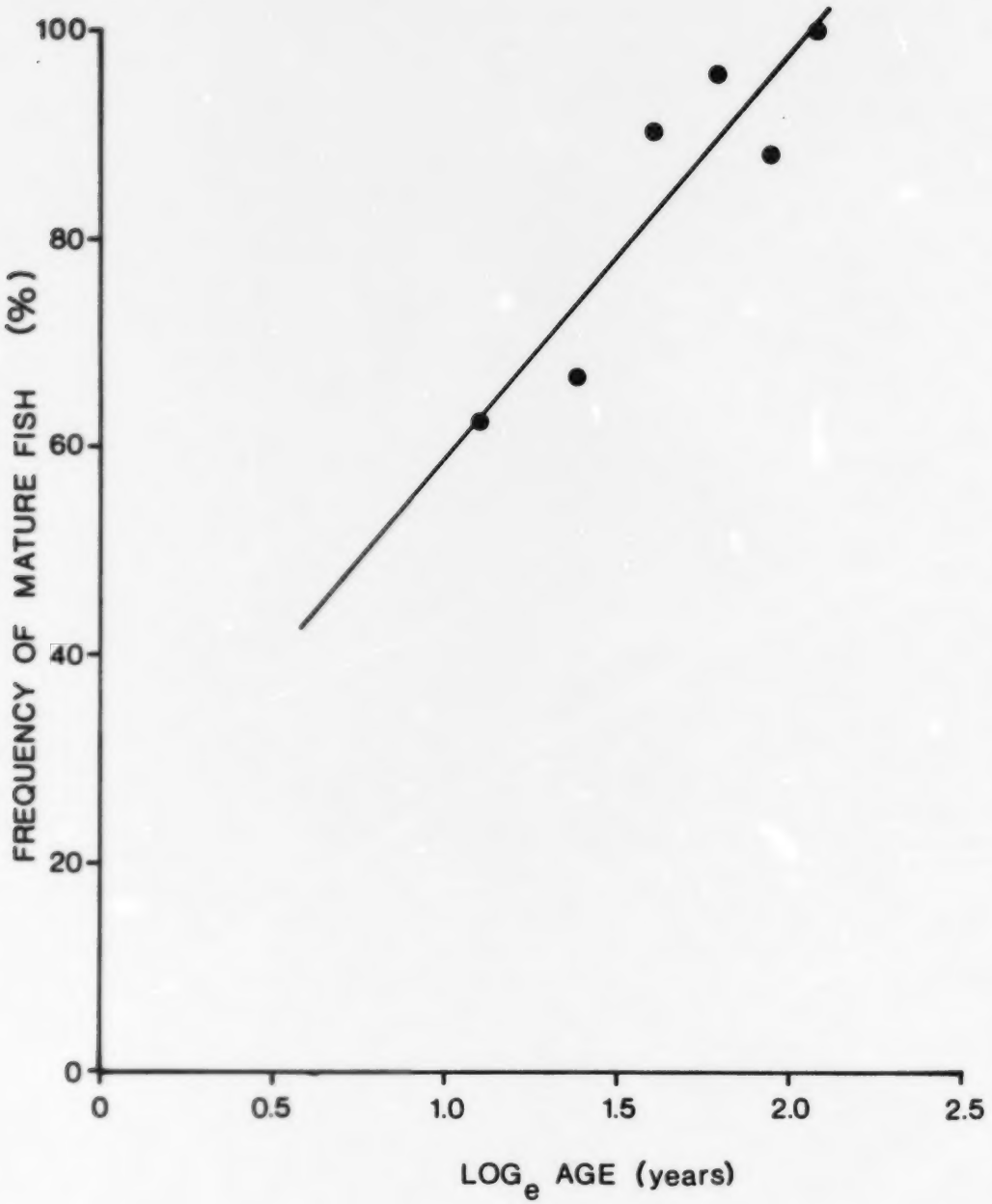

Fig. 15. Transformed maturity schedule of Cedar Lake whitefish.

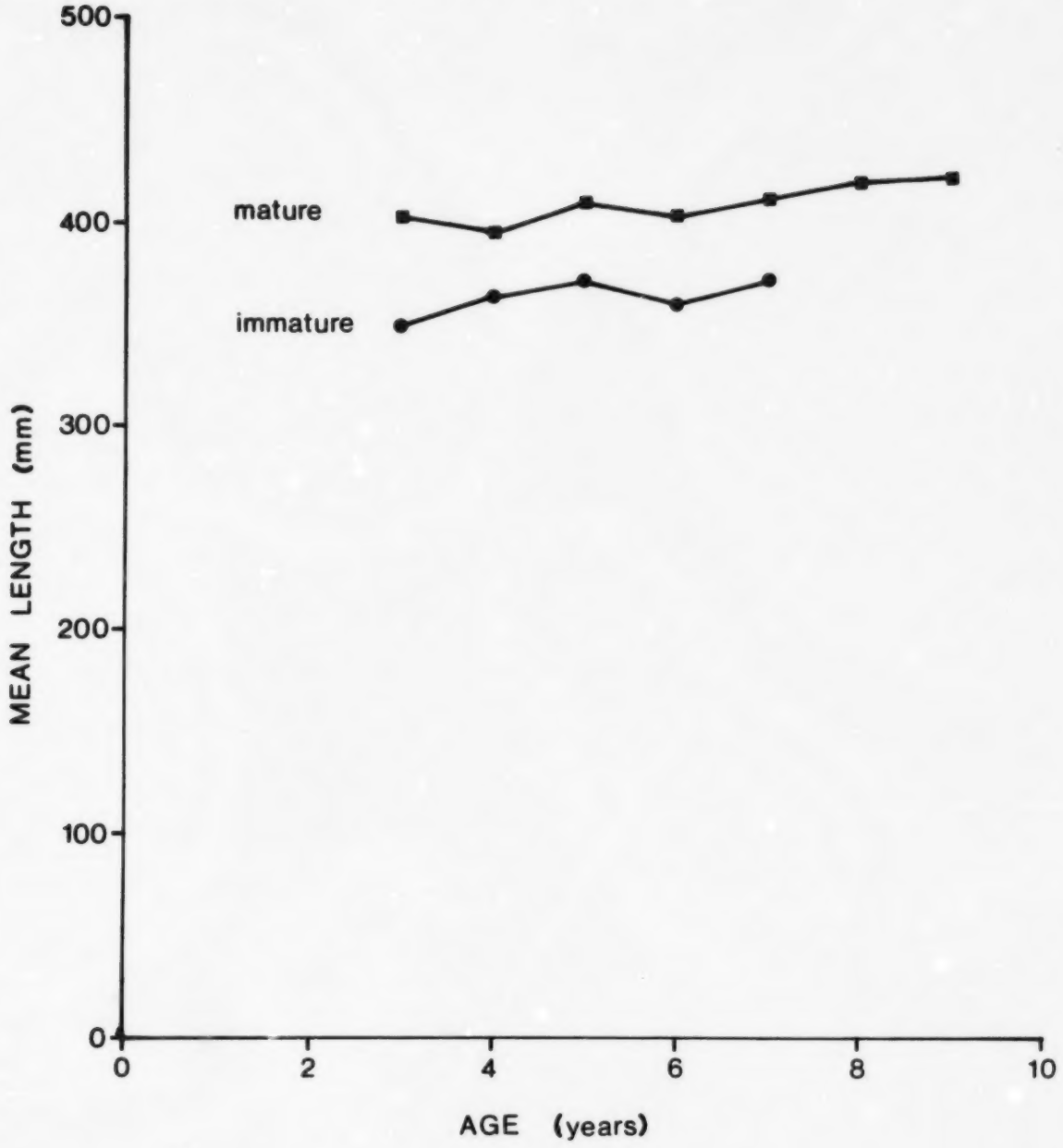

Fig. 16. Growth of immature and mature male walleyes from Cedar Lake, 1979.

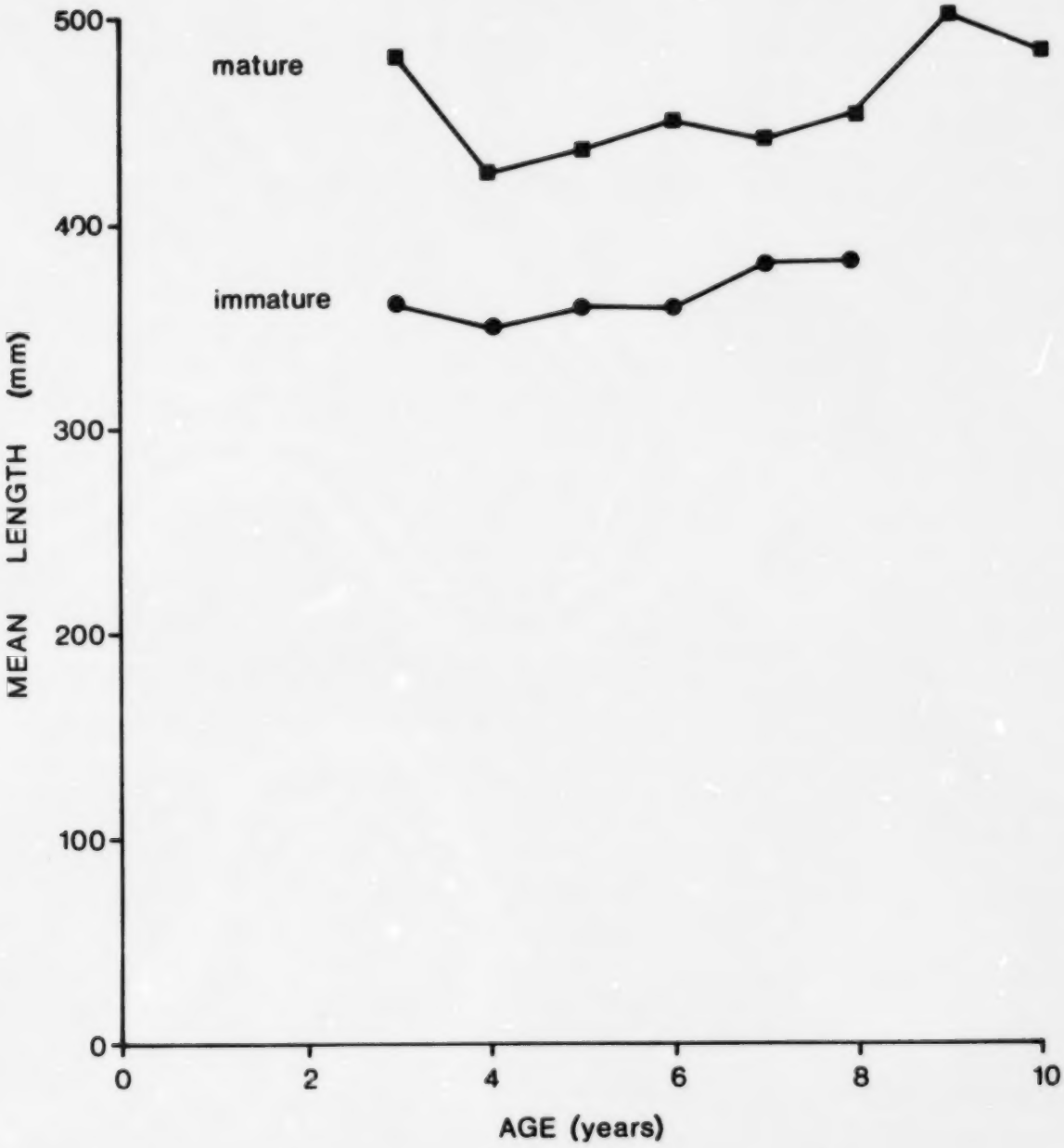

Fig. 17. Growth of immature and mature female walleyes from Cedar Lake, 1979.

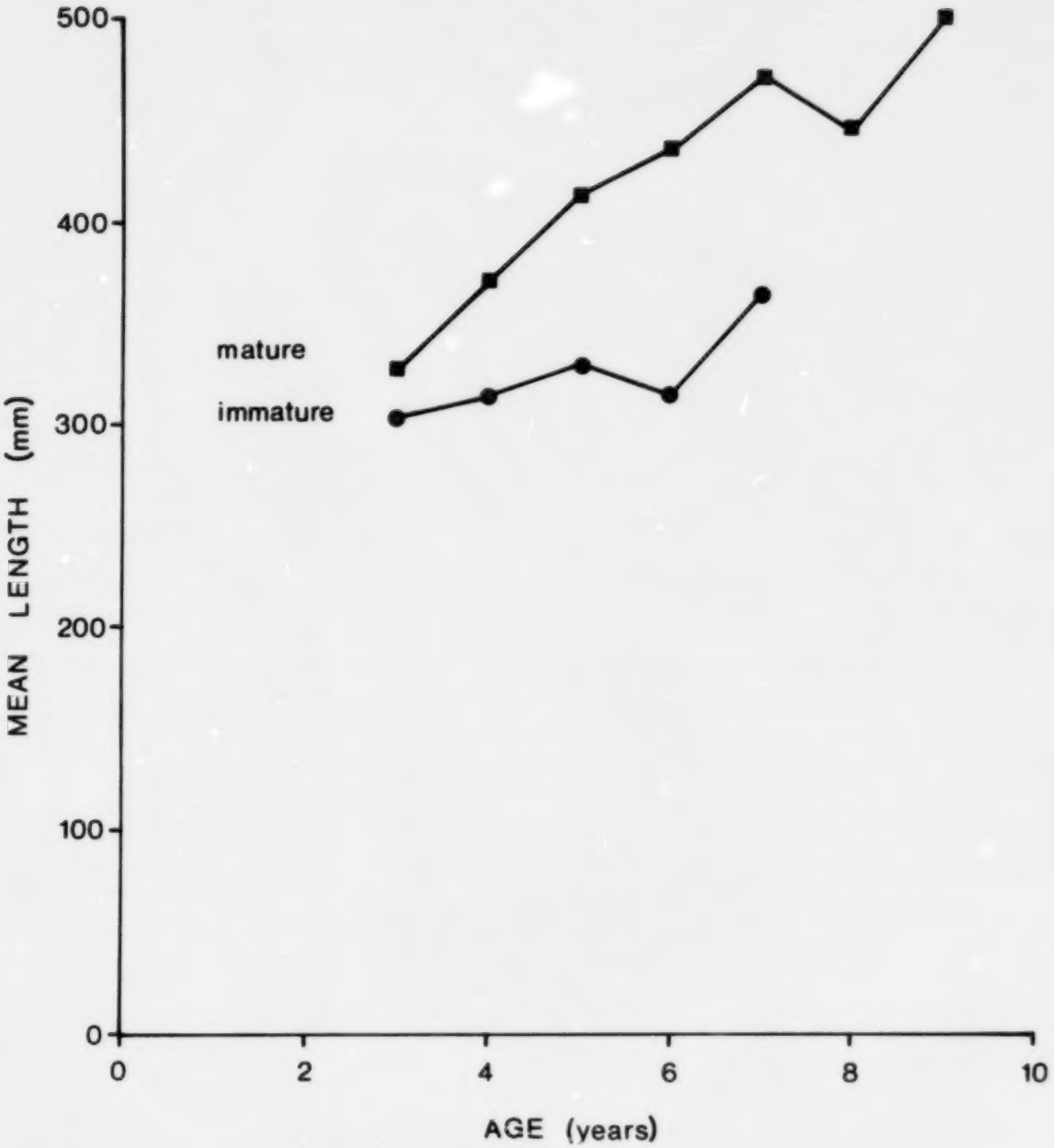

Fig. 18. Growth of immature and mature whitefish males from Cedar Lake, 1979.

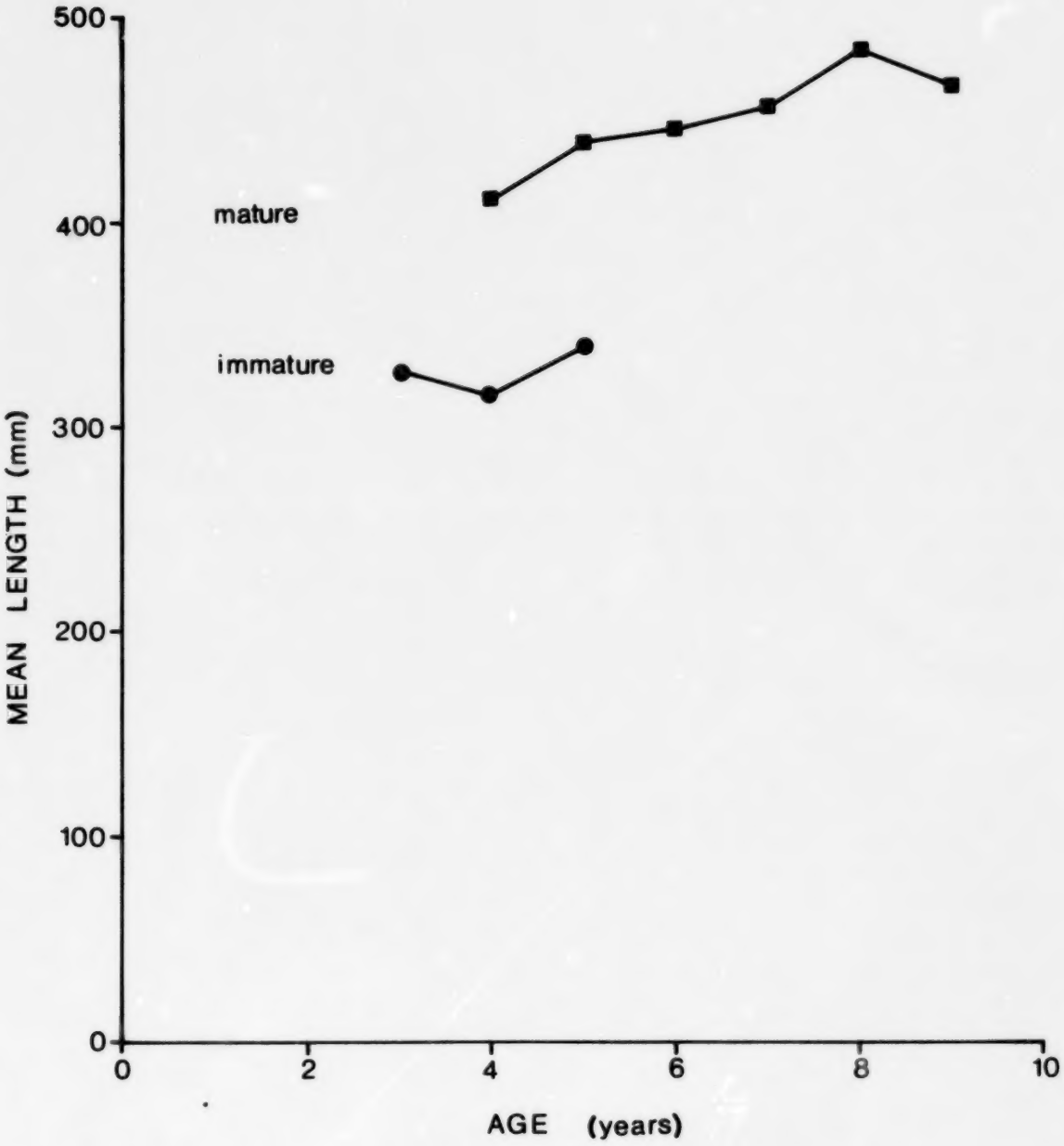

Fig. 19. Growth of immature and mature whitefish females from Cedar Lake, 1979.

polated age at which 50% of the fish are mature (Table 9), Abrasov's t index is +1.58 years for walleyes and +3.45 years for whitefish.

The fall commercial walleye sample was comprised of 3 immature males, 10 immature females, 52 mature males, and 25 mature females. Approximately 14% of the commercially caught walleyes were immature. The fall commercial whitefish sample was comprised of 12 immature males, 4 immature females, 80 mature males, and 69 mature females. Approximately 10% of the commercially caught whitefish were immature. 27% of the experimentally netted walleyes were immature and 13% of the experimentally caught whitefish were immature.

Six and seven year old walleyes predominated the spring and fall commercial catches. Autumnal catches contained fewer older walleyes than were present in vernal catches (Figs. 20, 21).

Four to six year old whitefish predominated the spring commercial catch while 5 and 6 year old whitefish predominated the fall catches. Autumnal catches contained more older whitefish than were present in vernal catches (Figs. 22, 23).

Discrepancies between walleye scale ages and mean otolith ages were slight (Fig. 24, Appendix A).

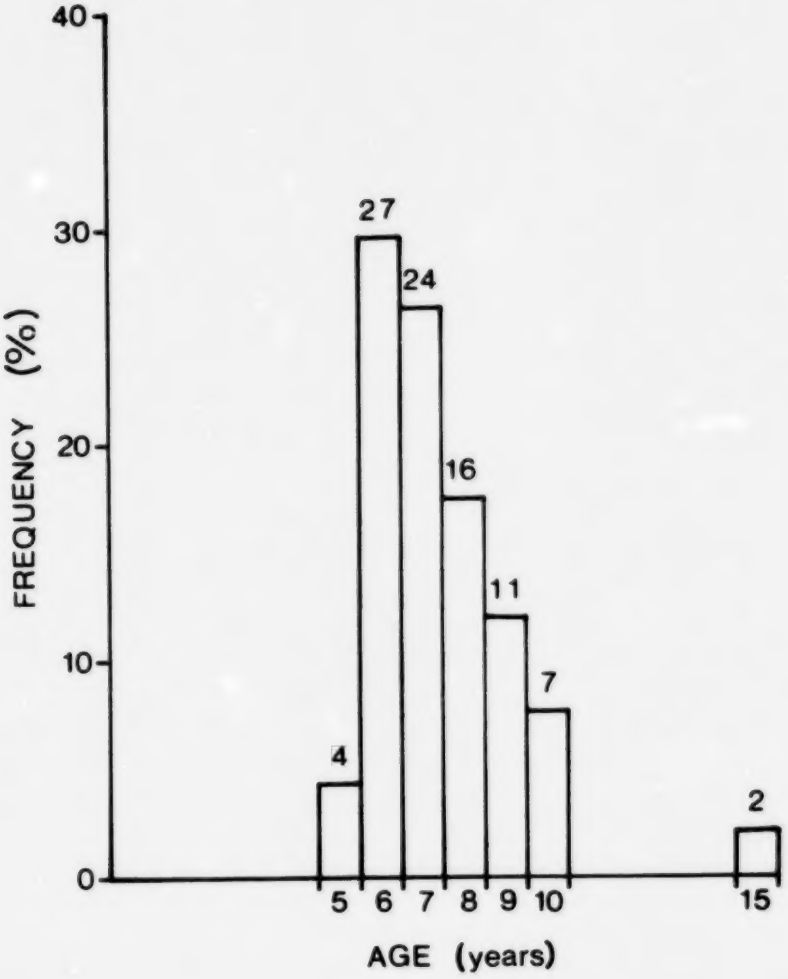

Fig. 20. Age composition of commercially caught walleyes from Cedar Lake, spring 1979. Number of fish in each age class are above each bar.

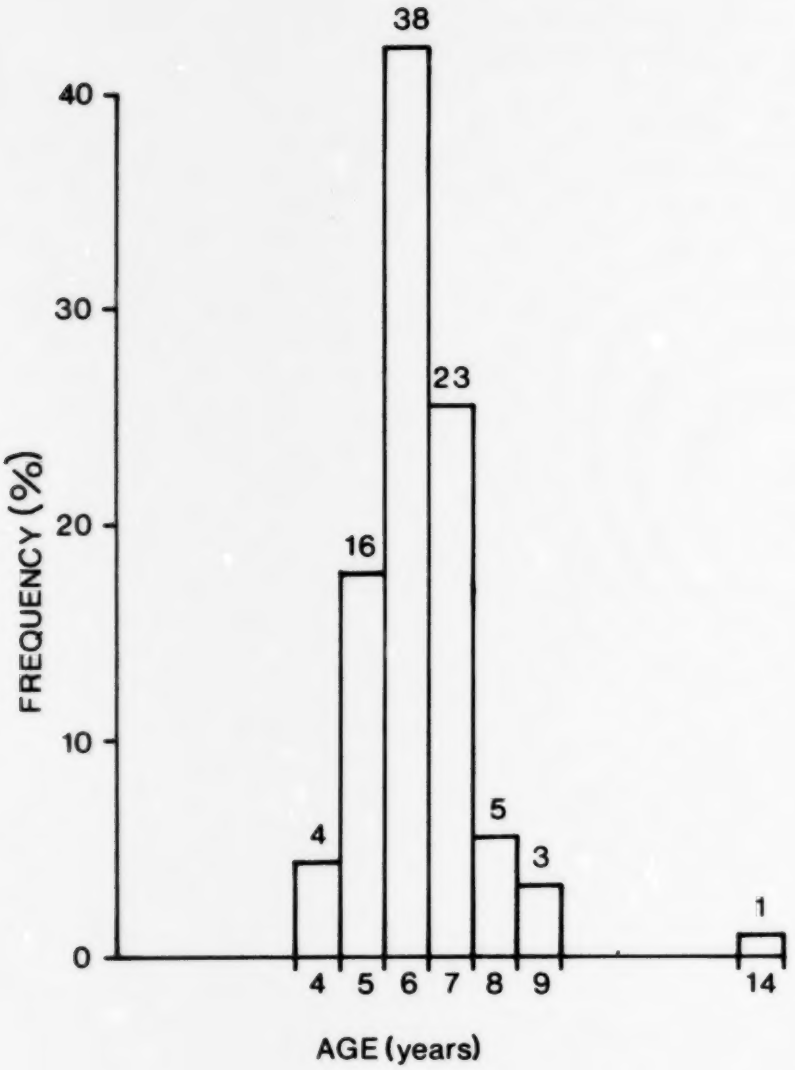

Fig. 21. Age composition of commercially caught walleyes from Cedar Lake, fall 1979. Number of fish in each age class are above each bar.

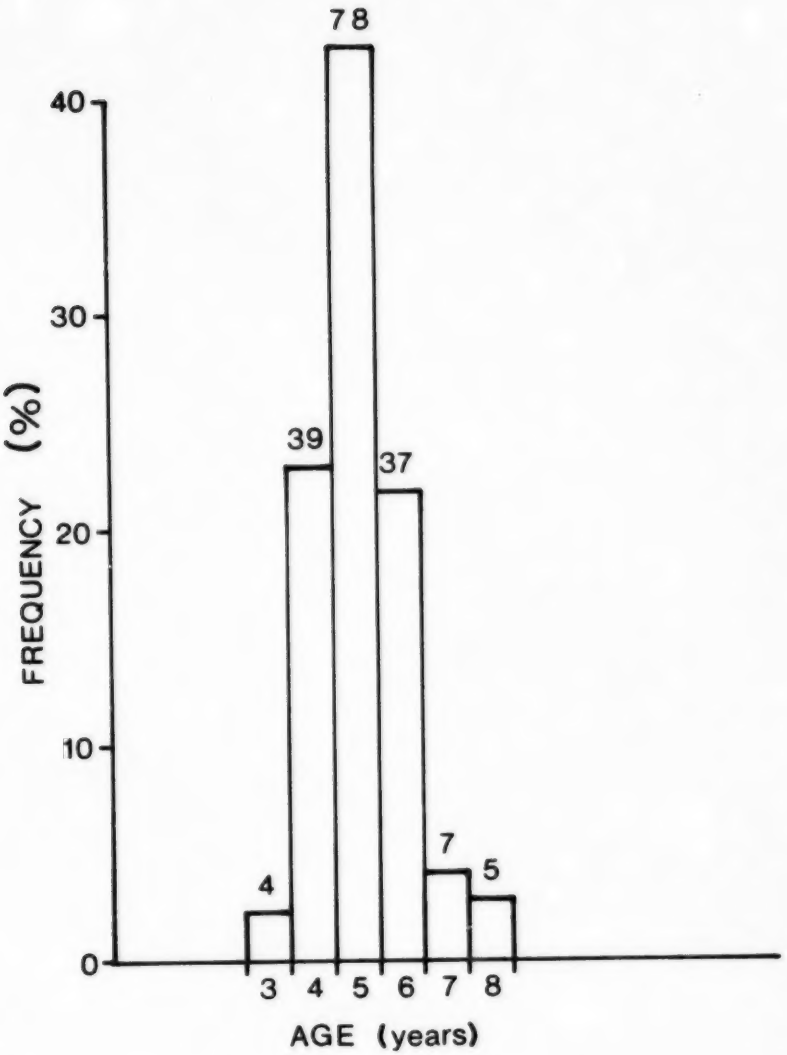

Fig. 22. Age composition of commercially caught whitefish from Cedar Lake, spring 1979. Number of fish in each age class are above each bar.

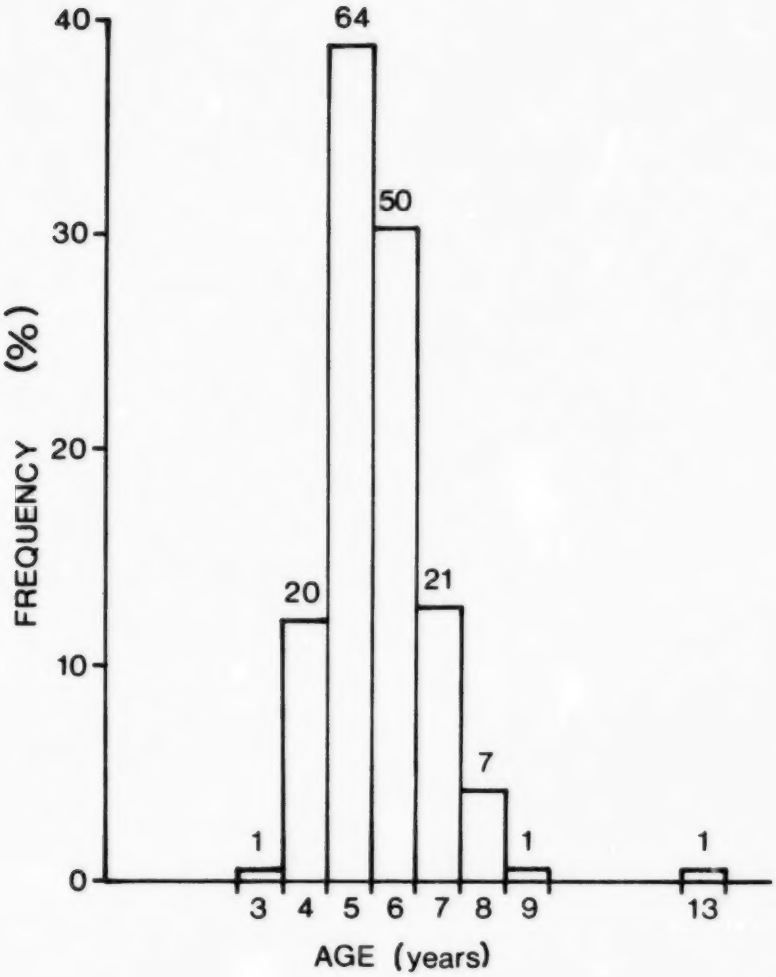

Fig. 23. Age composition of commercially caught whitefish from Cedar Lake, fall 1979. Number of fish in each age class are above each bar.

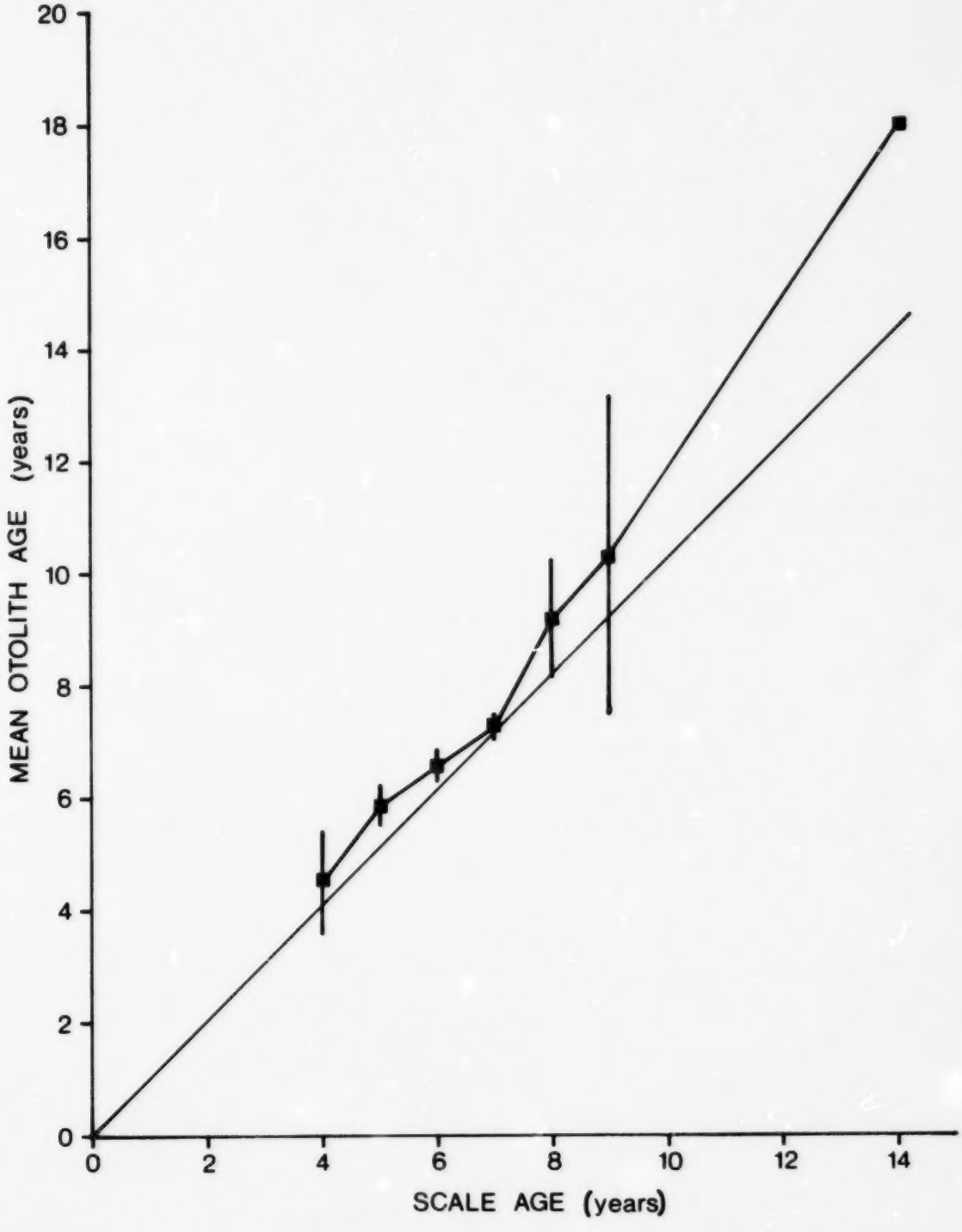

Fig. 24. Comparison of walleye scale and otolith ages. Vertical bars are 95% confidence intervals about each point. The slope of the agreement line is 1.

Table 7. Age-specific frequencies of mature walleyes and whitefish from Cedar Lake, 1979.

Species	Age (years)	No. immature fish			No. mature fish			% mature		
		males	females	total	males	females	total	males	females	total
Walleye	3	6	1	7	6	2	8	50.00	66.67	53.34
	4	20	15	35	28	10	38	58.33	40.00	52.05
	5	36	40	76	62	30	92	63.27	42.86	54.76
	6	30	41	71	81	36	117	72.97	46.75	62.23
	7	15	10	25	68	24	92	81.93	70.59	78.63
	8	1	2	3	15	14	29	93.75	87.50	90.63
	9	-	-	-	7	5	12	100.00	100.00	100.00
	10	-	-	-	3	5	8	100.00	100.00	100.00
	11	-	-	-	0	1	1	100.00	100.00	100.00
	12	-	-	-	2	0	2	100.00	100.00	100.00
								weighted mean age =		5.08
Whitefish	3	2	1	3	5	0	5	71.43	0	62.50
	4	3	2	5	7	3	10	70.00	60.00	66.67
	5	2	2	4	18	19	37	90.00	90.48	90.24
	6	2	-	2	23	21	44	92.00	100.00	95.65
	7	3	-	3	12	10	22	80.00	100.00	88.00
	8	-	-	-	4	2	6	100.00	100.00	100.00
	9	-	-	-	1	2	3	100.00	100.00	100.00
								weighted mean age =		3.96

Table 8. Correlation coefficients of maturity equations fitted by least squares regression using various transformations.

Species	Transformation		
	untransformed	% mature vs. log(age)	$\log(\frac{k - y}{y} + 1)$ vs. age
Walleye*	0.994	0.895	0.959
Whitefish	0.883	0.911	0.880

*first two points on the curve were deleted.

Table 9. Fitted maturity curves of Cedar Lake walleyes and whitefish, 1979.

Species	Linear equation	Correlation coefficient	Test F ratio and d.f.	Age 50% matu (years)
Walleye	% mature = -5.954 + 11.886 age*	0.994	254.29(1,4)	4.71
Whitefish	% mature = 19.784 + 38.778 log(age)	0.911	19.54(1,5)	2.18

*equation of curve b, Fig. 14.

Table 10. Age-specific mean lengths and weights of commercially caught walleyes and whitefish, fall 1979.

Species	Age (years)	No. fish	Mean length (mm)	Mean weight (gm)
Walleye	4	4	396.00	817.50
	5	16	416.13	934.38
	6	38	410.89	907.63
	7	23	432.87	1046.09
	8	5	460.00	1332.00
	9	3	439.33	1146.67
	14	1	582.00	2440.00
	$\bar{x}$ = 6.29		$\bar{x}$ = 422.36	$\bar{x}$ = 992.33
Whitefish	3	1	322.00	600.00
	4	20	414.10	1294.50
	5	64	424.31	1432.97
	6	50	439.70	1618.60
	7	21	464.57	1999.05
	8	7	471.14	2062.86
	9	1	492.00	2180.00
	13	1	570.00	3700.00
	$\bar{x}$ = 5.63		$\bar{x}$ = 435.52	$\bar{x}$ = 1584.42

DISCUSSION

Cedar Lake walleye growth is negatively allometric. Since the slope of the walleye length-weight relationship is almost three, the negatively allometric growth may be a sampling artifact or it may be the first indication of heavy exploitation. For example, sauger growth is negatively allometric in southern Lake Winnipeg and positively allometric in northern Lake Winnipeg. Southern Lake Winnipeg fishermen use smaller mesh nets and exert heavier pressure than northern Lake Winnipeg fishermen (Lysack & Ebbeling 1980). Hanford et al. (1977) suggest that since gillnets remove large, proportionately fat fish, selective pressures operate to favour proportionately skinnier fish. It is then expected that fish growth will become more and more negatively allometric as fishing pressure increases.

Cedar Lake walleye and whitefish growth curves are only partial curves that account for growth during older ages. The highest growth rates occur during the first four years of the walleye and whitefish life spans. 0+ to 4 year old fish were totally unrecruited to the experimental and commercial meshes on Cedar Lake. A Walford plot of walleye lengths failed to estimate asymptotic length, L_∞, because very few older walleyes were caught in experimental gangs. Apart from this shortcoming, walleyes seem to increase in length even during older stages of their lifespan. This may also be a function of underaging older fish since underaging tends to make a growth curve appear more linear than it is in reality. A Walford plot of whitefish lengths estimated L_∞ = 502 mm. This estimate is fairly reliable since the maximum length of commercially caught whitefish is 570 mm and the mean length is 436 mm.

Moshenko and Low (1979) found that the maximum length of whitefish from Great Slave Lake was between 570 and 579 mm. The mean

length of commercially caught whitefish from Great Slave Lake was 414 mm.

The leptokurtic character of both experimental and commercial walleye and whitefish age compositions indicates that the commercial fishery relies heavily on two or three age classes. The relative absence of fish older than six years implies that the Cedar Lake fishery has already passed through the "fishing up" phase. In 1973, the ages of commercially caught walleyes from Cedar Lake ranged from 6 to 13 years and the mean age was 8.7 years (Moshenko and McGregor 1978). Cedar Lake had been closed due to mercury contamination from 1970 to 1973 (Derksen 1978). In 1979, walleye ages ranged from 4 to 14 years and the mean age had decreased to 6.3 years. In 1973, the ages of commercially caught whitefish from Cedar Lake from 2 to 9 years and the mean age was 4.7 years (Moshenko and McGregor 1978). In 1979, whitefish ages ranged from 3 to 13 years and the mean age had increased to 5.63 years. These shifts in mean ages may be due to differences in ageing techniques between the two studies or they may indicate that fishing pressure on walleyes has increased and has decreased on whitefish.

Moshenko and McGregor's (1978) experimental gangs were identical to those used in this study. In 1973, the ages of experimentally caught walleyes ranged from 3 to 12 years and the mean age was 7.49 years. Whitefish ages ranged from 2 to 12 years and the mean age was 6.19 years. In 1979, the age range of experimentally caught walleyes was identical to the 1973 age range but the mean age had decreased to 5.85 years. In 1979, the age range of experimentally caught whitefish was compressed to 3 to 9 years and the mean age had decreased to 5.66 years.

Moshenko and McGregor's (1978) estimates of the instantaneous survival rates of commercially caught whitefish and walleyes were 0.510 and 0.194 respectively. In 1979 the instantaneous survival rates of

whitefish anddwalleyes were 0.355 and 0.317 respectively. The relatively high 1973 whitefish survival estimate was due to the bimodality of the catch curve which, in turn, was probably caused by the passage of two strong cohorts through the fishery. The walleye survival rate has increased since 1973 but in the light of other changes in the walleye population, this increase is probably an artifact created by increased precision in ageing scales of older fish (Erickson 1979).

Results of Moshenko and McGregor's (1978) study and this study both indicate that in Cedar Lake, walleye males begin to mature before females but mature at a slower rate than females. Similar patterns were observed for whitefish in both studies. The fact that a logistic transformation of the maturity curves presented in this study was inappropriate indicates that the sampling method is selecting fish that occupy an intermediate position on the maturity curve. This, in turn, makes it impossible to monitor annual changes in the inflection point of the maturity curve and casts doubt on the estimate of the age at which 50% of the individuals are mature.

The fact that at any common age, mature walleyes and whitefish are larger than their immature counterparts indicates that maturation is a size specific process rather than an age specific process.

Abrasov's (1967) t index was positive for both walleyes and whitefish irrespective of the methods used to calculate the mean age of maturity. Since the t index was only marginally positive for walleyes and whitefish, these species have only slightly more than once chance to spawn before they are caught.

In 1973, 4.8% of commercially caught walleyes were immature and 18% of commercially caught whitefish were immature (Moshenko and McGregor 1978). By 1979, the percentage of commercially caught immature

walleye had increased to 14% and the percentage of commercially caught immature whitefish had decreased to 13%.

In 1973, the Cedar Lake fishery relied heavily on only two age classes (8 and 9 year olds) of walleyes and two age classes of whitefish (4 and 5 year olds) (Moshenko and McGregor 1978). In 1979, the fishery was still heavily exploiting only two age classes of walleyes but these age classes had decreased to 6 and 7 year old fish. Conversely, the fishery is now exploiting older age classes of whitefish (5 and 6 years old).

MANAGEMENT RECOMMENDATIONS

1. In order to accurately monitor changes in growth and maturity rates relative to changes in fishing effort, it is strongly suggested that younger fish be caught. This implies the use of smaller meshes in the experimental gang or the use of trap nets.
2. A comprehensive catch-effort monitoring program should be instituted in order to allow comparisons of effort changes to changes in the population dynamics of the stocks. Such a program seems feasible because there are relatively few fishermen, species and mesh sizes being used in the fishery.
3. Various parameters of growth, maturity and mortality indicate that fishing pressure has been shifted from whitefish to walleyes since 1973. The fishery now relies more heavily on two younger age classes of walleyes than it did in 1973. Since the mean age of the walleye catch is approaching the mean age of walleye maturity, no further quota increases should be instituted until the effects of the most recent quota increase have been comprehensively described.

4. The institution of an individual quota system as opposed to an open or area quota system would be beneficial because it would dilute fishing intensity over time and would relieve heavy fishing effort during the spring and fall spawning periods.

5. Experimental sampling methods, locations and time periods should remain relatively standardized from year to year.

6. To obtain information about changes in the amount of immature fish being commercially exploited, commercial samples comprised of round or whole fish should be obtained.

7. Numbers of individuals of all species caught in experimental gangs should be recorded in order to monitor relative changes in species composition.

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APPENDIX A
Comparison of walleye scale ages and otolith ages

Table A1. Comparison of walleye scale ages and otolith ages.

Scale age (years)	No. fish	Mean otolith age (years)	95% confidence interval about mean
4	4	4.50	3.584, 5.417
5	15	5.87	5.512, 6.221
6	37	6.60	6.340, 6.849
7	21	7.29	7.075, 7.497
8	5	9.20	8.162,10.238
9	3	10.30	7.502,13.164
14	1	18	-